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Bound States of the Spin-Orbit Coupled Ultra-Cold Atoms RYTIS JURSENAS, JULIUS RUSECKAS, GEDIMINAS JUZELIUNAS, Institute of Theoretical Physics and Astronomy of Vilnius University, A. Gostauto 12, LT01108, Vilnius, Lithuania, IAN SPIELMAN, Joint Quantum Institute, National Institute of Standards and Technology, and University of Maryland, Gaithersburg, MD 20899, USA — Motivated by recent theoretical [1, 2] and experimental [3, 4] research, we consider the Hamiltonian for the one-dimensional atomic center of mass motion with the spin-orbit and Raman coupling included. The Hamiltonian is perturbed by a short-range potential describing the impurity scattering. We concentrate on the bound state problem, though the continuous spectrum of the Hamiltonian is of interest as well. We model the potential in terms of the Dirac delta function. By taking into account a correct treatment of the Dirac deltas [5, 6], we construct the associated self-adjoint operators and show that the number of bound states of the Hamiltonian under consideration is highly dependent on the treatment of the eigenfunctions at a zero point. Additionally, we establish all possible bound states and present their behavior in various regimes of both the spin-orbit and the Raman coupling. [1] J. Brüning et al, Phys. A: Math. Gen. 40 (2007), F113. [2] S. Takei et al, Phys. Rev. A 85 (2012), 023626. [3] Y.-J. Lin et al, Nature 471 (2011), 83. [4] L. W. Cheuk et al, Phys. Rev. Lett. 109 (2012), 095302. [5] F. A. B. Countinho et al. Rev. Bras. Ens. de Fis. 31 (2009), 4302. [6] D. Griffiths and S. Walborn, Am. J. Phys. 67 (1999), 446.

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